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THE NURSE AND HER RELATION TO IMMUNOLOGY VACCINES AND SERUMS IN THE TREATMENT AND PREVENTION OF DISEASE

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Immunity may be defined as the resistance of an individual to infection with microörganisms or their products which are infectious for other individuals of the same species.

Immunity arises through the formation of antibodies in the body. The mechanism of their production having been briefly outlined in a preceding paper, it is the purpose of this article to give a brief survey of various means now utilized in the treatment and prevention of disease which are based upon principles of immunology and which owe their existence and their effectiveness to the deliberate production and utilization of various specific antibodies in the human and animal bodies.

In order that the *modus operandi* may be understood it is necessary to amplify somewhat the definition of immunity given above. We recognize two great types of immunity: natural and acquired.

Natural Immunity is that form which is normally inherent in the body, the exact origin being unknown, though it is certain that heredity is an important factor in its occurrence. It may be illustrated by the immunity of negroes to yellow fever, for example, or by that of animals to many diseases to which man is subject (species immunity).

Acquired Immunity is that form of resistance to infection produced by the cells of the body as a result of having had the disease in question, or as a result of an artificially induced attack, or as a result of an artificial inoculation with a modified form of the causative agent, or, in a word, vaccination.

There are two subdivisions of acquired immunity which are of importance:

1. *Active acquired immunity,* produced by an accidental infection, an artificially induced attack of the disease, or by vaccination.

2. *Passive acquired immunity,* acquired through the introduction into the body of antibodies derived from another individual possessing active immunity.

Active acquired immunity, produced by the injection of vaccines, is utilized in the prevention and treatment of numerous infections, among the more important of which are typhoid fever, smallpox, rabies, acne, furunculosis, cholera, and bubonic plague.

It is obvious that the immunity thus utilized is acquired, because it was not previously present in the body of the individual; and active, because it is produced by the cells of his own body in reaction to the introduction of the vaccine.

Vaccines.—There are three types of vaccines, all of which consist of a modified form of the causative agent.

Bacterial vaccine is a term which properly includes all vaccines except those for smallpox and rabies, and is, in its simplest form, merely a suspension of *dead* bacteria in normal salt solution.

To produce or manufacture a bacterial vaccine it is necessary to obtain a growth or a *culture* of the organism not contaminated by the presence of any other bacteria, in other words, what is known as a *pure culture.* The growth is washed off and suspended in sterile normal salt solution, and the number of bacteria thus suspended is counted under the miscroscope to determine the number per cubic centimeter. The bacteria are then killed by heat, the suspension is diluted until the number desired per cubic centimeter is obtained, and a small amount of some antiseptic, generally phenol, added to prevent contamination. When placed in sterile ampules or other containers, this constitutes the finished vaccine.

If the bacteria were obtained from the patient's lesions, and this vaccine were made from his own bacteria, as it were, it is spoken of as an *autogenous* vaccine; if the culture from which it was made came from other sources, we speak of a *stock* vaccine.

Vaccines may contain only one kind of bacteria or several varieties. In the latter case we call them *mixed* vaccines.

If the bacteria are dead, how then does the injection of a bacterial vaccine stimulate the production of antibodies? The answer to this lies in the fact that one of the ways in which bacteria produce injury to the body cells is by means of an *endotoxin* by which is meant a toxin or poisonous substance contained within their bodies and liberated only on their death and disintegration. When we inject a bacterial vaccine we thus utilize the endotoxin which has been liberated from the bodies of the bacteria.

Smallpox vaccine, because of the fact that the cause of the disease has never been cultivated in pure culture, is an altogether different preparation from a bacterial vaccine, which is one of the reasons why the word vaccine should always be qualified by a descriptive adjective.

This preparation consists of cowpox virus, (which term means simply a poison and is used because the etiological agent is unknown), in a modified form and is secured from calves inoculated with the infection. The animals are, of course, carefully examined and tested for freedom from disease. The virus is suspended in glycerine and tested for bacterial sterility before use. In contradistinction to the bacterial vaccines, the virus is living.

Rabies vaccine is different from both the preceding though, like them, it consists of a modified form of the causative agent. In its production rabbits are inoculated with the rabies virus subdurally by a trephine operation. When the disease has developed, the animals are killed and the spinal cord, in which it is known that the virus is localized, is removed. The cords are hung up to dry in a semi-vacuum at a regulated temperature. As they grow older each day the virus weakens in strength, and a cord, according to its age, is spoken of as a "one-day virus," "two-day virus," and so on up to "twenty-one day virus."

The vaccine consists of a suspension of a weighed amount of the cord triturated in sterile glycerine, and the course of treatment begins with the oldest cord and progresses to the youngest cord,—and, therefore, toward the strongest virus.

Vaccines are of marked value in the prevention of disease as is well exemplified in smallpox, typhoid fever, and rabies. In the treatment of disease they have their greatest value in chronic infections in which the resistance of the individual is obviously low.

Serums: Serums produce *passive* acquired immunity because the active agent is not the patient to whom they are given, the patient merely acting as the passive recipient of antibodies produced by the cells of another individual.

Passive immunity, produced by the injection of serum, is always highly specific, and is utilized in a great variety of conditions, the most familiar of which are diphtheria and tetanus. Because the antibody which generally predominates is an antitoxin the serums are spoken of as antitoxins. The rationale of their production may be briefly described with profit.

The animal most frequently used for the production of immune serums is the horse, because it is susceptible and reacts to the injection of bacteria and their products, and because it can withstand the withdrawal of large amounts of blood. Healthy animals, which are carefully tested for infectious diseases, are chosen for injection. The substance which is injected, because it gives rise to (genesis) the formation of antibodies, is called an *antigen.* In the production of immune serums the character of the antigen depends somewhat upon the type of immune serum desired. If the bacteria produce a soluble toxin which it is desired to neutralize, then the toxin is injected; if the antitoxin is to neutralize an endotoxin, then the antigen consists of killed bacteria, and occasionally, both methods are combined.

As a rule the substance used as antigen is a toxin, the soluble poison produced by the bacteria and obtained by growing them in a liquid culture medium from which the bacteria are filtered off so that the liquid contains merely toxin in solution.

Following the injection, in response to the stimulation of the immune mechanism, as previously outlined, the blood of the horse contains free antitoxin. The injections are continued, each one containing a little more toxin, until, finally, the animal is able to withstand many times the ordinarily fatal dose of toxin. He is then bled and the serum so obtained constitutes the antitoxin. This is then tested for strength which is expressed in antitoxic *units*. A unit of antitoxin is that amount which will neutralize one hundred times the amount of toxin required to kill a 250 gram guinea pig.

All antitoxins are produced in a similar manner except that the character of the antigen used varies somewhat with the type of the organism in question.

Antitoxins constitute one of our most potent weapons in the treatment and prevention of disease, and are utilized in diphtheria, tetanus and numerous other conditions.

In the concluding paper of this series the practical application of immunological principles to the diagnosis of diseases will be described.

A PATIENT'S IMPRESSION OF A NURSE

By May Thomas Richards

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I had just regained consciousness and was vainly trying to distinguish various objects about me. Some one had just thrust a bolt of gauze down my throat and had twisted it about and then withdrawn it,—or so it seemed to me. The nurse who stood over me seemed immense, yet so far away.

"Water," I gasped. My throat was parched. Something cool and moist touched my lips, but it was not water, only a moist piece of gauze. Then Miss G., for that was the nurse's name, explained why she refused to give me water. Repeatedly I begged for it, and repeatedly she kindly but firmly refused.

Miss G. was far from being good to look upon, and I decided then and there to dislike her, but her sweetness, the gentleness and firmness of her touch, her soft smooth voice and the quiet manner